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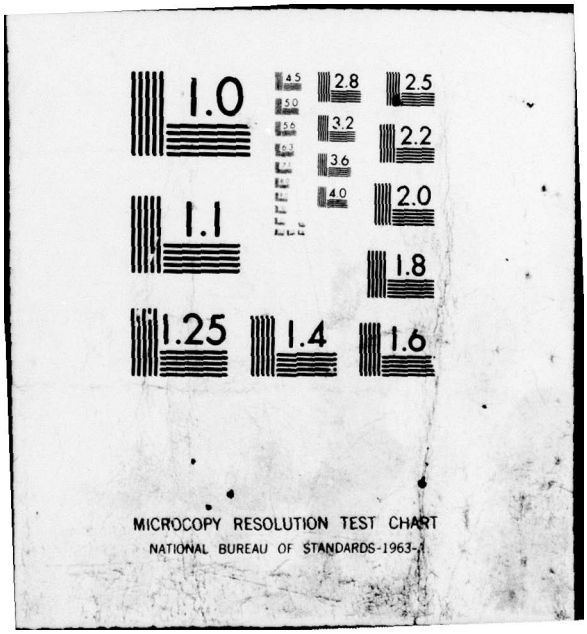
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*Final Report*

*November 1979*

LEVEL II

# ATMOSPHERIC ELECTRICITY AND MILITARY OPERATIONS

*By:* J. E. NANEVICZ

*Prepared for:*

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
ARLINGTON, VIRGINIA 22217



CONTRACT N00014-77-C-0326

SRI Project 6340



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SRI International

(9) Final Report

(11) November 1979

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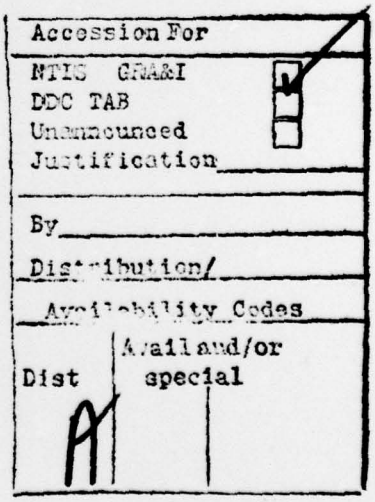
CONTENTS





# I INTRODUCTION

Since March 1963, Stanford Research Institute has been conducting research for the Office of Naval Research under Contracts Nonr-4099(00), N00014-71-C-0106, N00014-74-0134, and N00014-77-C-0326 on various problems in atmospheric electricity. The major results of this research have been published in a series of Scientific Notes; these notes are predominantly reprints of published papers based on research supported by the contracts. Under the first three contracts listed above, 27 Scientific Notes were prepared; these are summarized in the Final Report on Contract N00014-71-C-0106,[1] and the Final Report on Contract N00014-74-C-0134.[2] Under the present contract, three additional Scientific Notes have been prepared; these are summarized in Section II.

The research represented by the Scientific Notes has been performed very economically, from the aspects of both finance and manpower, due to certain special circumstances, among which are the following:

- Government-furnished equipment available at Stanford Research Institute could often be diverted to the ONR research.
- Much relevant expertise was acquired by SRI personnel in the course of other Institute projects.
- Data obtained under such projects could often be further analyzed to reveal information of basic scientific interest and of practical advantage to the U.S. Navy.
- The ONR work could frequently be carried out at propitious times on the general schedule of Institute activities.

Work on the present contract was greatly hampered by the untimely death of Dr. E. T. Pierce. He had assembled the relevant information

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[1] E. T. Pierce, "Basic Electrical Parameters of the Atmosphere," Final Report, Contract N00014-71-C-0106, SRI Project 4454, Stanford Research Institute, Menlo Park, California (January 1974).

[2] G. H. Price, "Radio Propagation and the Electrification of the Atmosphere," Final Report, Contract N00014-74-C-0134, SRI Project 3062, Stanford Research Institute, Menlo Park, California (January 1977).

and was in the process of writing several technical notes at the time of his death. The present author has completed these notes, but they undoubtedly have a different flavor and emphasis than would have been provided by Dr. Pierce.

## II SCIENTIFIC NOTES

This section lists the three Scientific Notes (SN) and their abstracts prepared on this project.

- Scientific Note 1: J. E. Nanevicz and G. R. Hilbers, "An Airborne Electric Field-Meter System Used for Studying Electric Field Structure Near Thunderstorm Cells," submitted for publication in Journal of Geophysical Research, Oceans and Atmospheres in August 1979.

  Abstract. In studying the electric-field structure in the vicinity of thunderstorm cells, it was necessary to design a special airborne electric field-measuring system capable of taking into account the field distortions caused by the presence of the aircraft. The form and magnitude of these field distortions were determined by a set of laboratory measurements using a scale model of the test aircraft. The resulting information was used to define a set of constants to be used in the real-time analog data processing system employed to convert local field meter sensor data into free-space field information.

  Since three components must be specified to define a field vector in space, at least three independent measurements must be made. However, since the system is airborne and any net charge residing on the aircraft will also make a contribution to the electric field at the skin, a fourth measurement must also be made to define the aircraft potential. Thus, the airborne field-meter system employed four rotating-vane field "mills" installed in the skin of the aircraft.

  Some of the important facets of the design and calibration of the airborne electric field-measuring system are discussed here.

- Scientific Note 2: J. E. Nanevicz, "A Triggered Lightning Strike to an Instrumented Learjet Aircraft," submitted for publication in Journal of Geophysical Research, Oceans and Atmospheres in August 1979.

Abstract: In connection with the operation of aircraft, there is always concern that the aircraft will suffer a lightning strike. In particular there is a question regarding whether the presence of the aircraft triggers a strike that otherwise would not have occurred, or whether the aircraft simply intercepts an already propagating stroke leader. An answer to this question has very practical implications regarding aircraft lightning avoidance.

Pierce, in SN 15 on a predecessor contract in this series, considered the problem of lightning triggering by man-made processes and collected accounts of known instances in which it was quite unequivocal that human intervention actually triggered the flash. The causal events include rocket firings, erection of tall structures, and even an underwater explosion. From his analyses of these incidents, he concluded that, provided certain conditions were satisfied, the introduction of a conducting body into a region of high electric fields will trigger a flash. He also observed that the cases of lightning-strike incidents to aircraft are poorly documented, since aircraft normally do not carry instrumentation appropriate for defining the ambient electrical conditions.

An opportunity to provide further insight into the aircraft lightning triggering problem presented itself in connection with flight testing using a NASA Learjet instrumented to measure the electric field structure in the vicinity of Florida Thunderstorms. On one of the test flights the instrumented aircraft was struck by lightning.

The general cloud conditions and the electrostatic field data preceding and during this flash are presented here in an effort to expand the data base available to the scientific

community concerned with lightning strikes to aircraft. The conditions existing prior to the stroke are discussed in the light of Pierce's triggering criteria.

- Scientific Note 3: J. E. Nanevicz, "Instrumented Learjet Aircraft Measurements of Static Electric Fields in and Around Florida Thunderstorm Anvils," to be submitted for publication in Journal of Geophysical Research, Oceans and Atmospheres.

  This paper, which is nearly complete, presents some of the experimental data generated during the 1975 and 1976 operations of the NASA Learjet in connection with the TRIP program in Florida.